X/132

OPERATING INSTRUCTIONS

for

TYPE 1304-A
BEAT-FREQUENCY OSCILLATOR

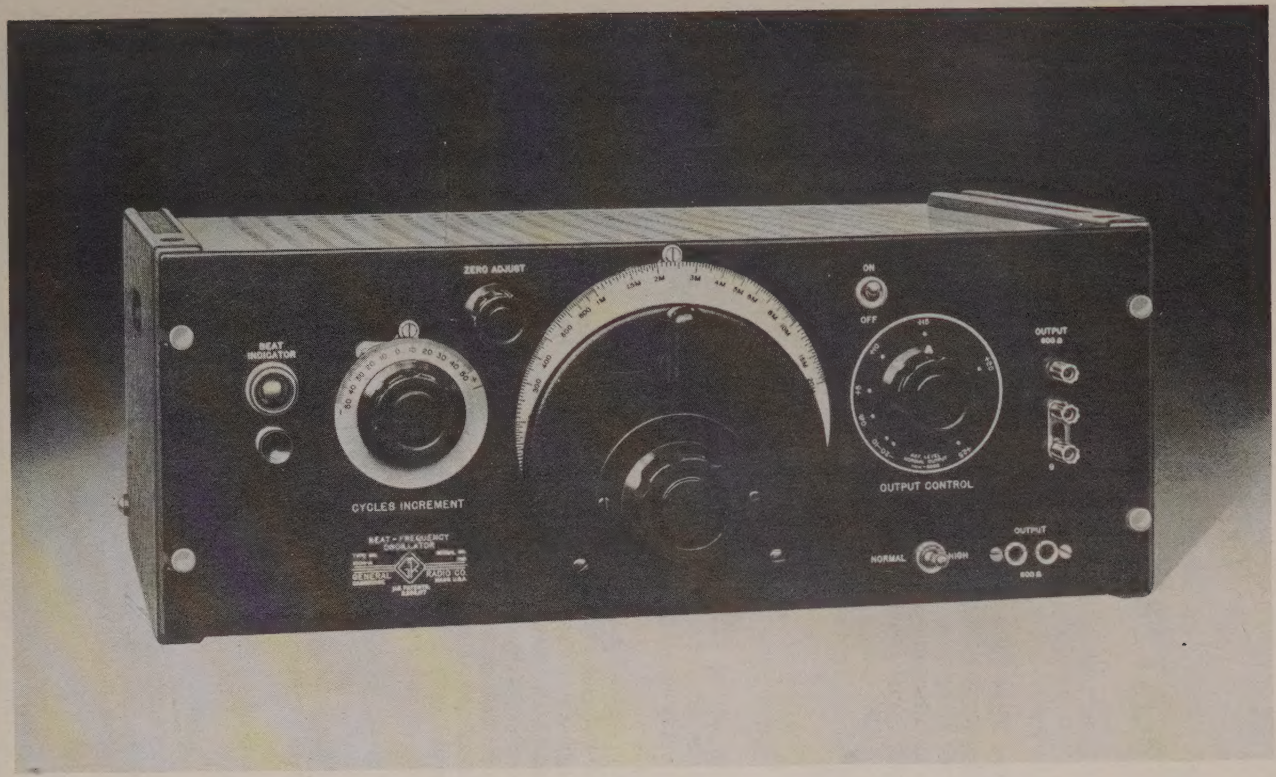
FORM 670-C

GENERAL RADIO COMPANY

CAMBRIDGE 39 MASSACHUSETTS

NEW YORK CHICAGO LOS ANGELES

U. S. A.



Panel View of Type 1304-A Beat-Frequency Oscillator.

OPERATING INSTRUCTIONS

for

TYPE 1304-A

BEAT-FREQUENCY OSCILLATOR

The Type 1304-A Beat-Frequency Oscillator is a power source for audio-frequency measurements. It delivers 0.3 watt at frequencies between 20 and 20,000 cycles, with a harmonic distortion of 0.5% or less, and a maximum output of one watt can be obtained at some sacrifice in purity of waveform. The gear-driven dial carries a logarithmic scale and can be readily coupled to an automatic analyzer or recorder. An increment dial is provided for producing small changes in frequency.

1.0 OPERATION

1.1 Mounting: The oscillator is equipped with walnut end frames for table mounting. These can be removed and the instrument mounted in a 19-inch relay rack, if desired.

1.2 Power Supply: Connect the oscillator to the power line by means of the cord-and-plug assembly provided. Be sure that the line voltage and frequency agree with those specified on the metal plate at the power input socket. Instruments are normally supplied for 115-volt operation. Power-transformer connections can be changed as indicated in the wiring diagram to convert the instrument to 230-volt operation. When connections are changed, the metal plate should be reversed to read 230 volts. When so ordered, instruments can be supplied with the transformer connected for 230-volt operation.

Throw the power switch to ON.

1.3 Ground: Connect the G terminal (on the panel) to an external ground in order to avoid hum.

1.4 Frequency Calibration: The frequency calibration can be standardized at either the power-line frequency or at zero. Where the power line is frequency-controlled, standardization at the line frequency is recommended.

When maximum accuracy of calibration is desired, it is advisable to check the standardization occasionally during the first few minutes of operation and to readjust if necessary. The drift is less than 7 cycles in the first hour of operation and is substantially complete after 2 hours.

1.41 Line-Frequency Standardization: Set main dial at the line frequency and CYCLES INCREMENT dial at zero. Turn ZERO ADJUSTMENT dial until the beat between the oscillator and power line frequencies is one

cycle in several seconds, as indicated by alternate glowing and extinguishing of the BEAT IND neon lamp. Make this adjustment carefully to get the beat as slow as possible.

1.42 Zero-Beat Standardization: Set main dial and CYCLES INCREMENT dial to zero. Adjust ZERO ADJUSTMENT dial until BEAT IND lamp goes out. This adjustment is sharp and must be made carefully.

1.5 Frequency Controls: After the calibration has been standardized, the output frequency is indicated by the setting of the frequency dials. The main frequency scale is logarithmic, and hence the dial can be set with the same fractional accuracy at any point.

The CYCLES INCREMENT dial permits small variations in frequency to be obtained above and below the frequency of the main dial setting. Its calibration adds algebraically to the reading of the main dial.

1.6 Output Switch: For best waveform, the instrument should be operated with the output switch set to the NORMAL position. This provides a maximum output of approximately 0.3 watt with less than 0.25% distortion over most of the audio-frequency range. When the switch is in the NORMAL position, the OUTPUT CONTROL is calibrated to read directly in terms of decibels power level into a matched resistive 600-ohm load.

Where more output is required at some sacrifice in purity of waveform, the output switch should be thrown to the HIGH position. This provides a maximum output of approximately 1 watt with some increase in distortion. (See Specifications.) The calibration of the OUTPUT CONTROL does not apply when the switch is in the HIGH position.

1.7 Load: The oscillator is designed to operate into a load impedance of 600 ohms, but it can be operated into an open circuit with no appreciable increase in distortion. With the OUTPUT CONTROL turned fully on, the harmonic content is approximately doubled when the oscillator is operated into an extremely low impedance. If the OUTPUT CONTROL is turned 3 db or more below the maximum setting, the load impedance has no effect on the waveform. Multipoint socket is also provided at the rear.

When the ground strap is disconnected from the lower output terminal, the output circuit is sufficiently well balanced for operation into most audio-frequency equipment.

When a plug is inserted in the Western Electric-type output jack on the panel all other output terminals are disconnected. The load may be balanced, but if one side is grounded, it should connect to the right side of the jack.

2.0 CIRCUIT DETAILS

2.1 General: The elementary schematic diagram of Figure 1 shows the elements of the oscillator which are: (1) a fixed oscillator operating at a frequency in the vicinity of 190 kc, (2) a second oscillator variable from 170 to 190 kc, (3) a mixer in which the difference frequency is produced, (4) a

low-pass filter for removing mixer components above the audio-frequency range, (5) an audio-frequency amplifier, (6) an output transformer, and (7) an attenuator.

The complete wiring diagram, Figure 2, shows the circuits in detail, including the power supply.

2.2 Oscillators: The oscillator tuned circuits use universal-wound coils on ceramic forms in order to achieve maximum mechanical stability.

The oscillator tubes are 6SL7 twin triodes, with the plate of the oscillator section grounded and the other section used as a cathode-coupled isolating amplifier. With grounded-plate operation, no tube shields are necessary to prevent capacitive coupling.

2.3 Mixer: The mixer tube is a 6SA7, operated with independent bias adjustments on the cathode and grid #3. This bias arrangement permits independent adjustment of output voltage and harmonic content.

2.4 Audio Amplifier: The low-pass filter is followed by a 6SL7-GT twin triode, the first section of which is operated as an amplifier and the second as a phase inverter. The output stage is a push-pull arrangement of 6V6-GT's.

2.5 Output System: The output circuit consists of the output transformer and volume control. A voltage from the tertiary winding of the output transformer is fed back to the cathode of the first audio amplifier tube to produce degeneration. The switch, S3, selects either of two values of this voltage, one corresponding to NORMAL output, the other to HIGH.

3.0 MAINTENANCE

Replacement of V-3, V-5, or V-6 may necessitate a few minor adjustments to restore the output level and to reduce the harmonic distortion introduced by variations in tube characteristics. When V-1 or V-2 is replaced, readjustments may be necessary before the oscillator can be set to zero frequency.

3.1 Adjustment for V-3: A wave analyzer with a high input impedance (one megohm) should be connected across the input to V-4 (terminal No. 4 and ground). These adjustments should be made at 1 kc. A slight readjustment of R-16 may be all that is necessary to reduce the second harmonic to a minimum. However, alternate adjustment of R-17 for 2.5 volts input to V-4 and of R-16 for minimum second harmonic will restore normal operation. R-16 and R-17 are screw-driver adjustments under the cap nuts just behind V-2, R-17 being the one nearer the main tuning capacitor.

3.2 Adjustment for V-5 and V-6: These adjustments should be made with a 600-ohm resistive load and a wave analyzer or distortion meter connected to the output terminals. R-32 should be adjusted for minimum second harmonic at a frequency of 100 cycles. Adjustment of R-38 will restore the maximum output voltage to 13.75 volts on the NORMAL output position and of R-39 to 24.5 volts on the HIGH output position. R-32 is located between V-5 and V-6; R-38 and R-39 are directly in front of the output transformer, R-39 being to the right.

3.3 Zero Frequency: If the oscillator cannot be set to zero-beat, adjust C-2, located just to the left of the ZERO ADJUSTMENT. Use the BEAT INDICATOR to determine when proper adjustment has been made.

4.0 SPECIFICATIONS

Frequency Range: 20 to 20,000 cycles.

Frequency Controls: The main control is engraved from 20 to 20,000 cycles per second and has a true logarithmic frequency scale. The total scale length is approximately 12 inches. The effective angle of rotation is 240°, or 80° per decade of frequency. The frequency-increment dial is calibrated from +50 to -50 cycles.

Frequency Calibration: The calibration can be standardized within 1 cycle at any time by setting the instrument to the line frequency or to zero beat. The calibration of the frequency control dial can be relied upon within ±(1% + 0.5 cycle) after the oscillator has been correctly set to zero beat. The accuracy of calibration of the frequency-increment dial is ±1 cycle.

Zero-Beat Indicator: A neon lamp is used to indicate zero beat at the line frequency or at zero scale.

Frequency Stability: The drift from a cold start is less than 7 cycles in the first hour and is essentially completed within two hours.

Output Impedance: The output impedance is 600 ohms, either grounded or balanced-to-ground, and is essentially constant regardless of the output control setting. With load impedances of 2000 ohms or less, the output is balanced for all settings of the output control. With higher load impedances, unbalance may occur at low settings of the output control.

Output Voltage: Approximately 25 volts open circuit. For a matched resistive load the output voltage varies by less than ±0.25 db between 20 and 20,000 cycles. The open-circuit output voltage is approximately 40 volts with the output switch in the HIGH position.

Output Control: The output control is calibrated from +25 to -20 db, referred to 1 milliwatt into 600 ohms.

Output Power and Waveform: NORMAL output 0.3 watt maximum when operated into matched load, with total harmonic content approximately 0.25% between 100 and 7500 cycles. Below 100 cycles the harmonic content increases, and may reach 0.5% at 50 cycles. A panel switch allows an increase in the output power to a maximum of 1 watt. For this HIGH position of the OUTPUT switch the distortion is less than 1% between 100 and 7500 cycles and increases to 2% at 50 cycles. With the OUTPUT control turned fully on, the harmonic content is approximately doubled when the oscillator is operated into a very low impedance. With the OUTPUT control turned 3 db or more below maximum load, impedance has very little effect upon the waveform.

A-C Hum: For NORMAL output the a-c hum is less than 0.1% of the output volts.

Terminals: Jack-top binding posts with standard 3/4-inch spacing and standard Western Electric double output jack are provided on the panel. A standard multipoint socket and plug provide duplicate output terminals on the back of the instrument for relay-rack installation.

Mounting: 19-inch relay rack panel; removable wooden ends are supplied so that it may be used equally well on a table.

Power Supply: 105 to 125 volts, 50 to 60 cycles a-c. A simple change in the connections to the power transformer allows the instrument to be used on 210 to 250 volts. The total consumption is about 100 watts.

Tubes:		
	3 - 6SL7-GT	2 - 6V6-GT
	1 - 6SA7	2 - 0D3/VT150
	1 - 5V4-G	1 - 991

All are supplied with the instrument.

Accessories Supplied: A seven-foot line connector cord and a multipoint connector.

Dimensions: 19-3/8 x 14-1/4 x 7-1/2 inches, over-all.

Net Weight: 41-1/2 pounds.

RESISTORS

				TYPE
R-1 =	1.8 Megohm	±10%	IRC	BT-1/2
R-2 =				
R-3 =	68 K Ohms	±10%	IRC	BT-1/2
R-4 =	1 K Ohm	±10%	IRC	BT-1/2
R-5 =	27 K Ohms	±10%	IRC	BT-1/2
R-6 =	1.8 Megohm	±10%	IRC	BT-1/2
R-7 =				
R-8 =	68 K Ohms	±10%	IRC	BT-1/2
R-9 =	1 K Ohm	±10%	IRC	BT-1/2
R-10 =	27 K Ohms	±10%	IRC	BT-1/2
R-11 =	15 K Ohms	±10%	IRC	BT-1/2
R-12 =	15 K Ohms	±10%	IRC	BT-1/2
R-13 =	16 K Ohms	±5%	IRC	BT-1/2
R-14 =	150 K Ohms	±10%	IRC	BT-1/2
R-15 =	150 K Ohms	±10%	IRC	BT-1/2
R-16 =	10 K Ohms			POSC-11
R-17 =	10 K Ohms			POSC-11
R-18 =	56 K Ohms	±10%	IRC	BT-1/2
R-19 =	75 K Ohms	±5%	IRC	BT-1
R-20 =	1.0 Megohm	±10%	IRC	BT-1/2
R-21 =	3300 Ohms	±10%	IRC	BT-1/2
R-22 =	100 K Ohms	±10%	IRC	BT-1/2
R-23 =	1.0 Megohm	±10%	IRC	BT-1/2
R-24 =	3900 Ohms	±5%	IRC	BT-1/2
R-25 =	18 K Ohms	±5%	IRC	BT-1/2
R-26 =	22 K Ohms	±5%	IRC	BT-1/2
R-27 =	560 K Ohms	±10%	IRC	BT-1/2
R-28 =	560 K Ohms	±10%	IRC	BT-1/2
R-29 =	10 K Ohms	±10%	IRC	BT-1/2
R-30 =	10 K Ohms	±10%	IRC	BT-1/2
R-31 =	165 Ohms	±5%		REPO-1076
R-32 =	100 Ohms			POSW-862
R-33 =	12 K Ohms	±10%	IRC	BT-1/2
R-34 =	12 K Ohms	±10%	IRC	BT-1/2
R-35 =	10 K Ohms	±10%	IRC	BT-1/2
R-36 =				
R-37 =	560 Ohms	±10%	IRC	BT-1/2
R-38 =	300 Ohms			POSW-862
R-39 =	300 Ohms			POSW-862
R-40 =	430 Ohms	±5%	IRC	BT-1/2
R-41 =	Outer			471-445
R-42 =	Inner			
R-43 =	100 K Ohms	±10%	IRC	BT-1/2
R-44 =	82 K Ohms	±10%	IRC	BT-1/2
R-45 =	560 K Ohms	±10%	IRC	BT-1
R-46 =	450 Ohms			REPO-1090-27
R-47 =	450 Ohms			
R-48 =	450 Ohms			
R-49 =	1000 Ohms			REPO-1090-28
R-50 =	1000 Ohms			
R-51 =	1000 Ohms			
R-52 =	1000 Ohms			
R-53 =	120 Ohms	±10%	IRC	BW-1/2
R-54 =	50 Ohms			POSW-862
R-55 =	100 K Ohms	±10%	IRC	BT-1/2
R-56 =				

CAPACITORS

				TYPE
C-1 =	5 μμf			368-413
C-2 =	140 μμf			COA-5
C-3 =	0.001525 μf	±1%	AEROVOX	1464
C-4 =	0.00016 μf	±10%	CD	5W
C-5 =	0.5 μf	±10%		COL-44
C-6 =	7 μμf			COT-17
C-7 =	0.00015 μf	±10%	CD	5W
C-8 =	0.0005 μf	±10%	CD	5W
C-9 =	415 μμf		GR	539-410-4
C-10 =	140 μμf			COA-5
C-11 =	0.0015 μf	±1%	AEROVOX	1464
C-12 =	0.00016 μf	±10%	CD	5W
C-13 =	7 μμf			COT-17
C-14 =	0.00005 μf	±10%	CD	5W
C-15 =	0.0005 μf	±10%	CD	5W
C-16 =	0.5 μf			COL-44
C-17 =	0.00005 μf	±10%	CD	5W
C-18 =	200 μf	+50%,-10%		COEB-8
C-19 =	15 μf			
C-20 =	0.000025 μf	±5%	CD	5W
C-21 =	50 μμf			COA-2
C-22 =	0.15 μf	±5%		COL-57
C-23 =	0.000025 μf	±10%	CD	5W
C-24 =	0.15 μf	±5%		COL-57
C-25 =	0.25 μf	±20%		COL-56
C-26 =	0.25 μf	±20%		COL-56
C-27 =	0.005 μf	±5%	CD	1W
C-28 =	0.005 μf	±5%	CD	1W
C-29 =	0.005 μf	±10%	CD	1W
C-30 =	40 μf	+50%,-10%		COEB-17
C-31 =	40 μf			
C-32 =	40 μf	+50%,-10%		COEB-17
C-33 =	40 μf			
C-34 =	20 μf	+50%,-10%		COEB-9
C-35 =	20 μf			
C-36 =	20 μf			
C-37 =	20 μf			
C-38 =	0.01 μf	±10%	CD	3L
C-39 =	0.01 μf	±10%	CD	3L
C-40 =	0.001 μf	±10%		CON-358*
C-41 =	3 μμf			846-402
C-42 =	10 μμf	±10%		CON-288

S-1 = Switch DPST SWT-333
S-2 = Switch DPST SWP-809
S-3 = Switch DPDT SWT-335

T-1 = Transformer 365-417-3
T-2 = Transformer 485-422-2

P-1 = Pilot Light 2LAP-939
PL-1 = Plug CDPP-562A

J-1 = Jack CDSJ-818
J-2 = Jack CDSJ-818

SO-1 = Socket CDMS-1401-4

L-1 = Inductor 913-322
L-2 = Inductor 913-322
L-3 = Inductor 260 mh - 119-30

F-1 = Fuse 1.25 amp Slow Blow 3AG GR FUF-1 (115V)
F-2 = Fuse 1.25 amp Slow Blow 3AG GR FUF-1

F-1 = Fuse 0.6 amp Slow Blow 3AG GR FUF-1 (230V)
F-2 = Fuse 0.6 amp Slow Blow 3AG GR FUF-1

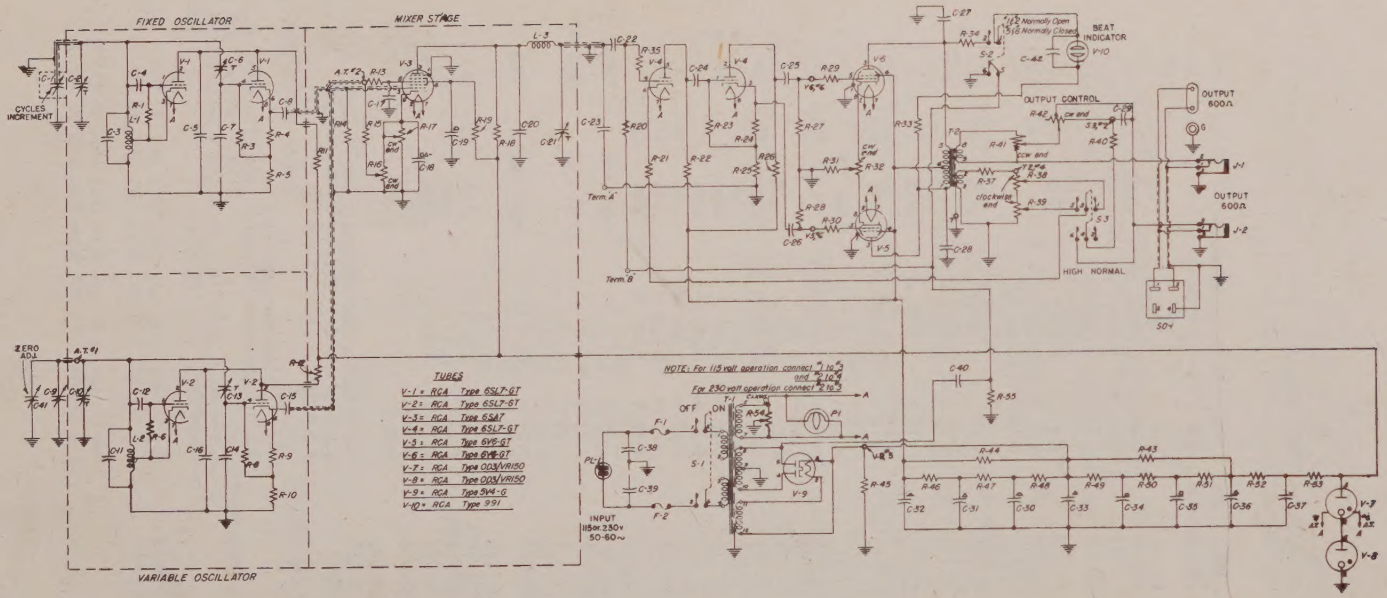

FIXED OSCILLATOR
MIXER STAGE
VARIABLE OSCILLATOR
CYCLES INCREMENT
ZERO ADJ.
BEAT INDICATOR
OUTPUT CONTROL
OUTPUT 600Ω
HIGH NORMAL
TUBES
V-1 = RCA Type 6SL7-GT
V-2 = RCA Type 6SL7-GT
V-3 = RCA Type 6SA7
V-4 = RCA Type 6SL7-GT
V-5 = RCA Type 6V6-GT
V-6 = RCA Type 6V6-GT
V-7 = RCA Type OD3/VR150
V-8 = RCA Type OD3/VR150
V-9 = RCA Type 5Y4-G
V-10 = RCA Type 931
NOTE: For 115 volt operation connect 1 to 3 and 2 to 4
For 230 volt operation connect 2 to 3
INPUT 115 or 230V 50-60~

Figure 2. Wiring Diagram for Type 1304-A Beat-Frequency Oscillator.

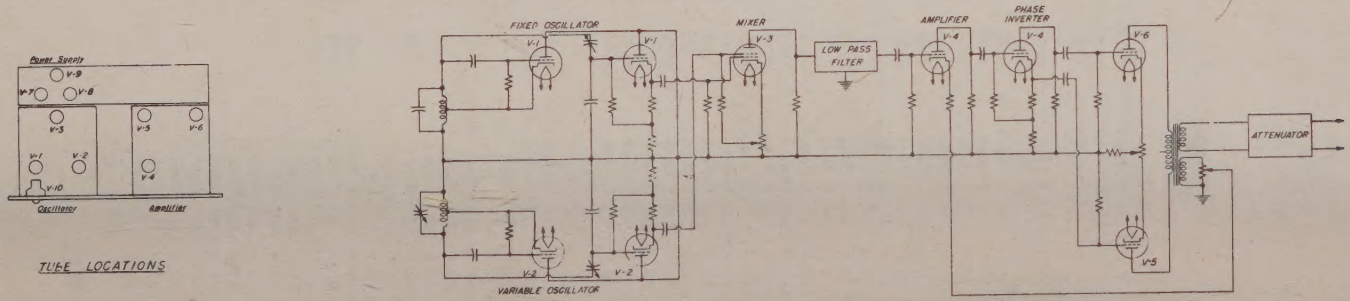


Figure 1. Schematic Diagram for Type 1304-A Beat-Frequency Oscillator.